

While the preferred embodiment of the invention is disclosed herein, the scope of the invention is not necessarily limited to the preferred embodiment. Many changes are possible and these changes are intended to be within the scope of the disclosure. For example, the wave generator assembly 24 need not be confined to an —80:1 angular motion reduction but the ratio can clearly be changed and varied to a high degree as the design requires. What is important is that the number of teeth on the outwardly directed flexible race member be a fixed number of teeth less than the number of inwardly directed teeth of the rigid outer stationary ring gear. In this manner, an harmonic wave generator may be applied and used to provide a nanometric drive apparatus. Consequently, the specific configuration of the harmonic drive, or the construction of the nanometric drive system are merely representative, and are deemed to afford the best embodiment for purposes of disclosure and for providing support for the claims which define the scope of the present invention.

What is claimed is:

1. A nanometric drive apparatus, providing superimposed coarse and fine adjustments of linear displacements, comprising:

an elongated displacement shaft having an axis, and a plunger on the forward end, and integrally connected to a coarse adjustment means at the rearward end;

means for nanometric adjustment;

a harmonic wave generator means coupled to said nanometric adjustment means; and

frictional shaft engagement means, coupled to said harmonic wave generator means, for rotating said elongated displacement shaft and advancing said plunger forward along the axis of said shaft, whereby, said nanometric adjustment means may be used to provide nanometric linear displacement to said shaft along said axis to supplement coarse adjustments which may be made independently by said coarse adjustment means.

2. The nanometric drive apparatus of claim 1 wherein said nanometric adjustment means is a fine adjustment knob.

3. The nanometric drive apparatus of claim 1, wherein the harmonic wave generator means includes: a substantially rigid, stationary ring gear having a plurality of inwardly directed teeth;

a flexible outer race having a plurality of outwardly directed teeth which engage the inwardly directed teeth of said ring gear;

said shaft coupled as an output for said ring gear;

a rigid elliptical inner race; and,

a plurality of ball bearings interposed between said inner and outer races, said ball bearing acting to generate a wave motion of the flexible outer race against the ring gear so that a substantial reduction of motor between said inner race and said outer race may be effectuated.

4. The nanometric drive apparatus of claim 3 further including a flexible cup supported by said stationary ring gear,

said flexible cup being coupled to said flexible outer race; and,

said elliptical inner race being connected to said nanometric adjustment means, whereby said nanometric adjustment means may be used to activate said harmonic wave generator means to provide nanometric linear displacement of said shaft.

5. The nanometric drive apparatus of claim 4, wherein said shaft engagement means includes a bearing friction sleeve which continuously engages said displacement shaft when said flexible cup is rotationally deformed;

said flexible cup rotationally coupled to said bearing friction sleeve and in intimate frictional journaled engagement with said coarse adjustment means.

6. A nanometric drive apparatus, comprising:

an elongated linear displacement shaft having a plurality of finely pitched threads at its forward end, the threads located adjacent to a plunger and capable of revolving within a nut body which surrounds said shaft;

said shaft including an enlarged reentrant thimble located at mid-body along said shaft and a coarse adjustment knob integral with said shaft at the rearward end of said shaft, for controlling the rotation of said threads within said nut body;

a nanometric displacement control knob surrounding said shaft and superimposed and concentric with said coarse adjustment knob;

a harmonic wave generator means coupled to said nanometric displacement control knob and providing control independent of said coarse adjustment knob to achieve nanometric displacement of said shaft in an axial direction; and,

said harmonic wave generator means including a deformable cup and a bearing friction sleeve attached to said deformable cup,

said sleeve being in journaled engagement with said enlarged reentrant thimble, allowing said harmonic wave generator means to nanometrically drive said linear displacement shaft.

7. The nanometric drive apparatus of claim 6, wherein said harmonic wave generator means includes:

an outer stationary ring gear integral with the housing of said drive, said ring gear having a plurality of radially inward directed teeth for engaging radially outward directed teeth on said deformable cup;

said deformable cup having a plurality of outwardly directed teeth engaging said ring gear at a plurality of selective locations along the inner circumference of said ring gear; and

rolling wave generating means for producing a harmonic wave on said deformable cup so as to rotate said cup inside said ring gear; and

said bearing friction sleeve is frictionally coupled to said linear displacement shaft

so that said linear displacement shaft is capable of nanometric movement in an axially forward direction and retraction in an axially rearward direction.

8. The nanometric drive apparatus of claim 7, wherein said rolling wave generating means comprises: a flexible outer race;

a rigid elliptical inner race; and

a plurality of ball bearings sandwiched between said flexible outer race and said rigid elliptical inner race;

said inner race being linked to a nanometric displacement control knob;

said outer race being operatively connected to said deformable cup,

whereby said nanometric displacement control knob may effectuate nanometric displacements of said shaft by initiation of a rolling wave within said harmonic wave generator means.